



# Development of Forced Pulse Water Strip of HVOF Coatings and Chrome Plating on Aircraft, Landing Gear, Engine and Propeller Components

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# Agenda & Project Overview

## Agenda & Project Overview

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## USAF SBIR Phase II Awarded to ES3

USAF SBIR Number F071-317-0028

Phase II Period of Performance: 23Jul09 – 22Jul11

### Joint SBIR between:

Hill AFB, Robins AFB, FRC-East and Southeast

USAF and USN Phase II SBIR POCs

Frank Zahiri, WRALC SBIR Program Mgr

Scott Wrigley, C-5 SPO, WR-ALC

John Jacobs, Robins AFB

Mike Schow, Hill AFB

Robert Kestler, FRC-East

Tai Ngin, FRC-Southeast

### ES3 teamed with VLN Advanced Technologies

### Commercialization Interest:

Messier-Dowty, Boeing, Heroux-Devtek,  
Goodrich, KLM, Delta Air Lines, and others



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## Acknowledgement of Support and Disclaimer

**ES3 would like to acknowledge the US government's support in the publication of the SBIR related material developed under this contract. All Phase II SBIR related material is based upon work supported by the United States Air Force under Contract No. FA8501-09-0037. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the United States Air Force.**

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**The objective of Phase II SBIR is to validate the crack detectability and fatigue characteristics of the substrates after pulse waterstrip application.**

## **Hill AFB: Focus is Landing Gear**

**300M High Strength Steel substrates, 280-300 KSI  
HVOF coating is WC-Co  
Chrome plating**

## **Robins AFB: Focus is Aircraft and Propeller**

**4340 Low Strength Steel substrates  
HVOF coating is WC-Co-Cr  
Chrome Plating**

## **FRC-East and Southeast: Focus is Engine**

**Inconel 718 substrates  
HVOF coatings are Cr-C and T-800**



# Benefits

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**A process that will strip both chrome plating and HVOF coatings from high & low strength steel, and Inc718 alloys**

**Elimination of multiple wet chemical strip tanks**

**Elimination of hydrogen embrittlement issues that are associated with the wet chemical strip process**

**Elimination of embrittlement relief bakes**

**Reduced process time**

**Environmentally friendly process**

**Utilization of basic water (no abrasives) in a recycled system**

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**Phase I SBIR feasibility testing successfully completed and report submitted to the USAF in 2008.**

**Phase II SBIR has initiated.**

**Collecting demonstration and validation parts**

**Manufacturing coupons**

**Parameter Development for INC718 coated panels**

**Phase III SBIR Commercialization efforts underway for technology insertion.**

**Plans to insert into production in POC depots.**

**Other depots and companies are invited to contact us for their specific needs and other substrate/finish applications.**

**OEM's being coordinated with for complimentary test programs.**



# Project Status

## Phase I SBIR Test Results

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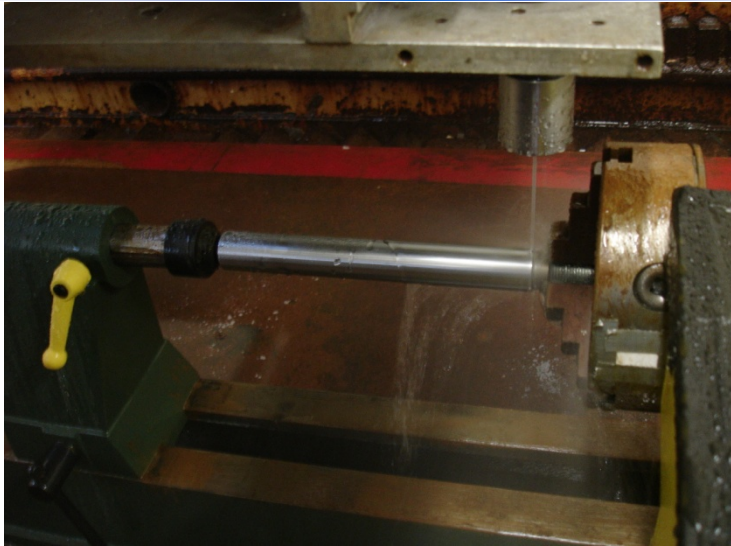
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**Left: View of Chrome plated, HSS coupon prior to pulse waterstrip.**

**Right: View of the coupon after complete chrome plating removal by pulse waterstrip.**

**View typical for LSS. Process time was approximately 60 seconds to remove 0.005 inch thick chrome plating along the length of a 1 inch diameter, eight inch long coupon. There is no visual or dimensional damage to the HSS substrate.**



# Project Status

## Phase I SBIR Test Results

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Surfaces were visually inspected under 25X magnification to observe surface texture characteristics.

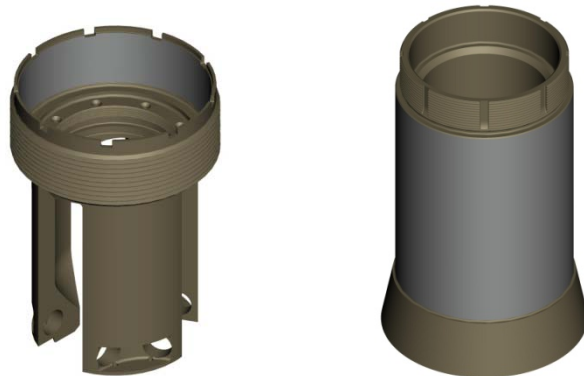
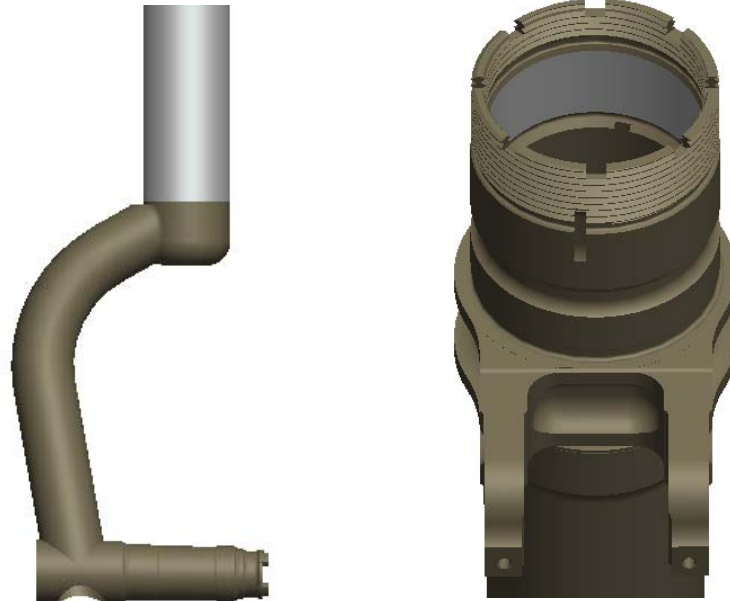


# Project Status

## Phase II SBIR Dem/Val Parts

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**F-15 NLG Piston Axle (top left) and F-16 HW NLG Inner Cylinder (top right). Gray shaded areas are plated/coated regions on HSS Steel.**



**C-130 Propeller Lever Support Sleeve (bottom left) and C-5 Horizontal Stabilizer Pivot Shaft (bottom right). Gray shaded areas are plated/coated regions on LSS steel.**

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## Phase II SBIR Dem/Val Parts

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**F-404 Fan Drive Shaft (top)**  
**Mfg from INC718**  
**Coated with HVOF T-800**



F404 Fan Drive Shaft

**J52 Rear Compressor Drive Turbine Shaft (bottom).**  
**Mfg from INC718**  
**Coated with Cr-C**



J52 Rear Compressor Drive Turbine Shaft

# Project Status

## Phase II SBIR Parameter Development

**Initial Parameter Development has been started for Cr-C and T-800 coated INC 718 flat panels.**

**Example view of a coated flat panel showing initial parameter development testing results and how different parameter settings affect the coating and substrates.**



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# Boeing Test

## Feasibility Test Results

**Boeing prepared coupons with HVOF WC-Co-Cr coatings and chrome plating and conducted a preliminary feasibility test with the Pulse Waterjet Strip process on:**

**4340M (280-300ksi)**

**15-5PH steel (180-200 ksi)**

**6Al-4V Titanium (130 min ksi)**

**Coupons were processed at VLN and results indicated the plating and coatings could be removed, and that further parameter development and testing was necessary in order to establish stable parameters to eliminate substrate damage.**

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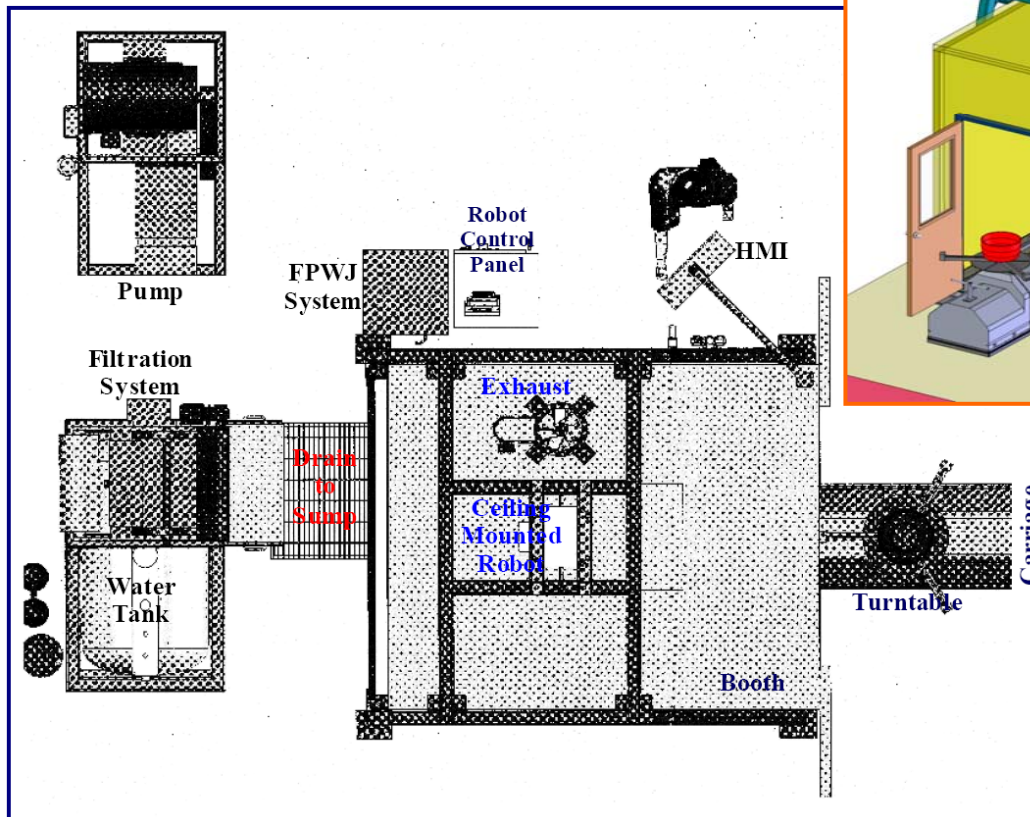
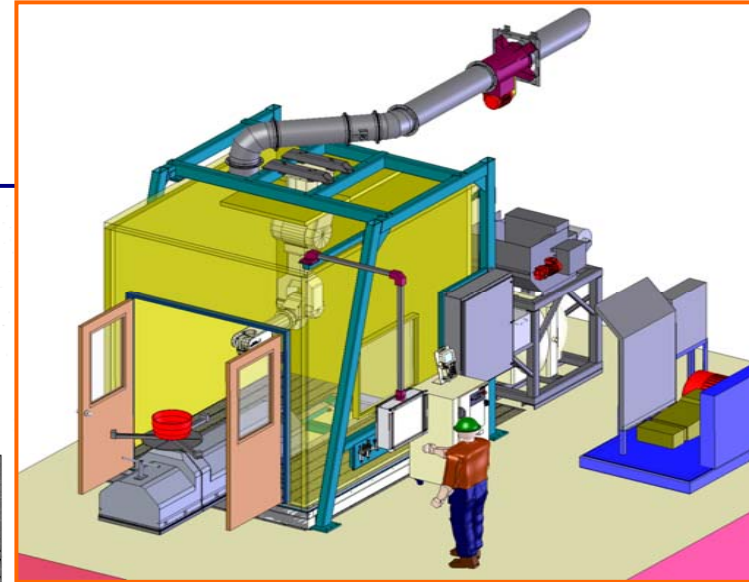


# Booth Design

## Automated Pulsed Waterjet Stripping System (APWSS)



### Conceptual Design (right)



Plan View of  
system installed at  
Vector Aerospace  
by VLN. (left)



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# Booth Design

## Automated Pulsed Waterjet Stripping System (APWSS)



**View of HMI and robot control box near the window of the booth (right)**

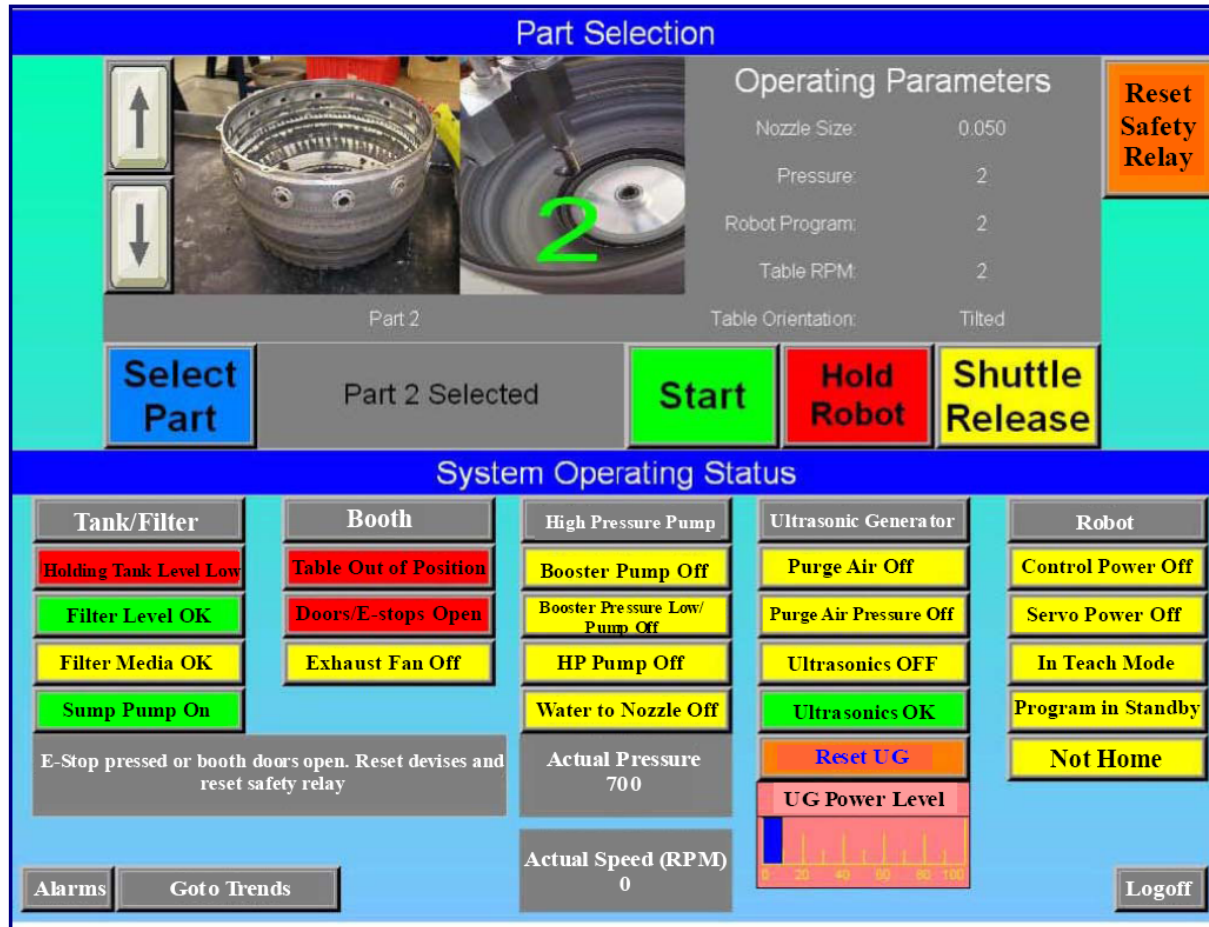


**View of system installed at Vector Aerospace by VLN. (left)**



# Booth Design

## Automated Pulsed Waterjet Stripping System (APWSS)



View of HMI screen



# Contact Information

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# Questions?